Kuwait University **Physics Department**

Physics 101
Solution of the First Midterm Examination
October 21, 2001
Sunday, 12:30 – 2 PM

Name: ---------- Student Number: ----------

الحل المعتمد

Instructor's Name: ----------

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For use by Instructors only

Problem	1	2	3	4	5	6	7	8	9	Total
Marks										

1- Answer all questions
2- The solution should be given explicitly for each problem
3- No. solution = no grade.
4- Check the correct answer for each question.
5- Take g=10 m/s^2.

1. The position of a particle along the x-axis is given by $x(t) = 2t^3 - 6t^2 + 4$, where t is in seconds and x is in meters. What is the average acceleration during the time interval t=1s to t=3s.

(a) $18\,m/s^2$ (b) $16\,m/s^2$ (c) $12\,m/s^2$ (d) $24\,m/s^2$ (e) other

Solution

$$v = \frac{dx}{dt} = 6t^2 - 12t$$

$$v(3) = (6)(9) - (12)(3) = 18m/s$$

$$v(1) = (6)(1) - (12)(1) = -6m/s$$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{18-(-6)}{3-1} = \frac{24}{2} = 12m/s$$

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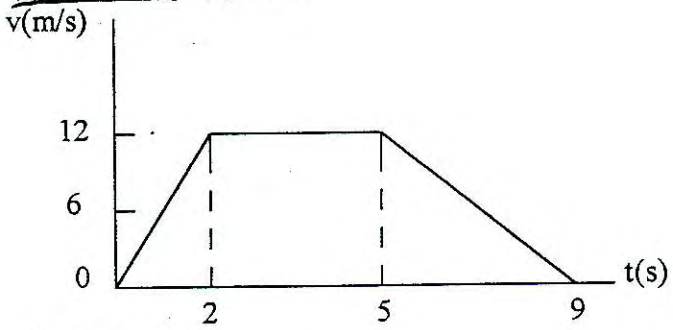
2. The diagram represents the straight-line motion of a car. Determine the acceleration at t = 6 seconds.

(a) $0\,m/s^2$ (b) $3\,m/s^2$ (c) $-3\,m/s^2$ (d) other

Solution



The acceleration at (t=6 sec) = slope of the line at t=6 sec.

$$a_x = \frac{0-12}{9-5} = \frac{-12}{4} = -3m/s^2$$

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3. Two particles A and B are projected together in the same direction. The particle A is projected with constant velocity of 50 m/s, while particle B is projected with initial velocity of 10 m/s and constant acceleration of $4\,m/s^2$. The time (in seconds) required for particle B to overcome particle A is

(a) 10s (b)20s (c) 40s (d) other

Solution

For A: $\Delta x = v_o t = 50t$

For B: $\Delta x = v_o t + \frac{1}{2}at^2 = 10t + 2t^2$

$50t = 10t + 2t^2$

$40t = 2t^2$

$t = 20s$

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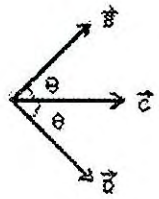
4. Three vectors $(\vec{B},\vec{C},\vec{D})$ all have the same magnitude. The angle θ between adjacent vectors is 45° as shown. Show that the magnitude of $\vec{B}+\vec{D}$ is equal to $\sqrt{2}C$.

Solution



The angle between $\vec{B}$ and $\vec{D}$ is 90°, A=B=C

The magnitude of $\vec{B}+\vec{D} = \sqrt{B^2+D^2} = \sqrt{C^2+C^2} = \sqrt{2C^2} = C\sqrt{2}$

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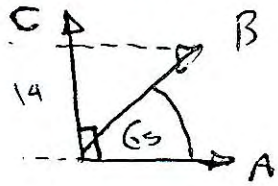
5. Two vectors $\vec{A}$ and $\vec{B}$ have magnitudes of A=10 and B=15. The angle between them is 65°. The component of vector $\vec{B}$ along the line perpendicular to vector $\vec{A}$, in the plane of the vectors is (a) 0 (b) 4.2 (c) 6.3 (d) 9.1 (e) 14



Solution

The component is = 15 cos (90-65) = 15 cos 25 = 13.59 ≈ 14

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6. If $\vec{A} = 2\hat{i} - 3\hat{j}$ and $\vec{A}x\vec{B} = 14\hat{k}$. Find the vector $\vec{B}$ in unit vector notation if

$B_y = 2B_x$ and $B_z = 0$

(a) $2\hat{i}+\hat{j}+\hat{k}$ (b) $2\hat{i}+4\hat{j}$ (c) $4\hat{i}+2\hat{j}$ (d) other

Solution

$\vec{A}x\vec{B} = (2i-3j)x(b_x i + b_y j) = 2b_y k + 3b_x k$

$14k = (2b_y k + 3b_x k)$

$14k = (2(2b_x) + 3b_x)k$

$7b_x = 14$

$b_x = 2$

$b_y = 4$

$\vec{B} = 2i + 4j$

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7. A baseball is kicked. After a time of 3.77s, it strikes a wall that is 130 m horizontally from the player at a height 20 m above the ground level. Find the initial speed of the ball (v_o). (a) 42 m/s (b) –42 m/s (c) 32 m/s (d) other

Solution

$$x - x_o = v_{xo}t$$
$$130 = v_{xo}(3.77s)$$
$$v_{xo} = \frac{130}{3.77} = 34.48m/s$$
$$y - y_o = v_{yo}t - \frac{1}{2}gt^2$$
$$20 = v_{yo}(3.77s) - 5(3.77)^2$$
$$v_{yo} = \frac{20 + 71.06}{3.77} = 24.154m/s$$
$$v = 34.48i + 24.15j$$
$$s = \sqrt{34.48^2 + 24.15^2} \approx 42m/s$$

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8. A particle moves with a constant speed of 60 m/s around a circle of radius r. If the particle completes one round in 50 s. Find the magnitude of its acceleration.
(a) 8.8 m/s^2 (b) 7.5 m/s^2 (c) 9.4 m/s^2 (d) 6.3 m/s^2 (e) 5.3 m/s^2

Solution

$$a_r = \frac{v^2}{r}$$
$$2\pi r = vt$$
$$r = \frac{vt}{2\pi}$$
$$a_r = \frac{(v^2)(2\pi)}{(v)(t)} = \frac{(60)(2\pi)}{50} = 7.5m/s^2$$

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9. Two ships A and B, leave port at the same time. Ship A travels due east with a speed of 20 km/h with respect to the earth and ship B travels 48 degrees north of east with a speed of 30 km/h with respect to the earth. Determine the velocity of A relative to B?.
(a) 22 km/h toward east (b) 22 km/h toward the north (c) 22 km/h toward the south
(d) 22 km/h toward south east.

Solution

$$v_{AE} = (20i)km/h$$
$$v_{BE} = (30km/h, 48°)$$
$$v_{AB} = v_{AE} + v_{BE} = 20i - (30\cos 48°i + 30\sin 48°j) = 20i - 20.07i - 22.29j = (-22.29j)km/h$$
= 22 km/h toward the south